CLAIMS

1. A method for improving speech quality, in a communication system comprising a first terminal unit (TRX1), which transmits speech signals having a first sampling frequency (F_1) and a second terminal unit (TRX2), which receives said speech signals, and buffers them in a playout buffer with said first frequency (F_1) and plays them out with a second frequency (F_2) said method

characterised by

performing a dynamic sample rate conversion of a speech frame comprising N samples on a sample by sample basis, said dynamic sample rate conversion comprising the steps of

creating an LPC-residual, comprising N samples, derived from said speech frame;

calculating, for each speech frame, whether a sample should be either added or removed from said LPC-residual;

generating a modified LPC-residual comprising N-1 or N+1 samples, if said calculating so demands; and

synthesising a speech signal from said modified LPC-residual.

2. The method of claim 1 **characterised** in that the creating step comprises performing an LPC-analysis of the speech frame in order to find LPC-parameters of said speech frame.

3. The method of claim 1 **characterised** in that the creating step comprises using already existing LPC-parameters from a speech decoder.

4. The method of claim 1 **characterised** in that the creating step comprises using an existing LPC-residual from a decoder.

5. The method of any of the preceding claims **characterised** in that the calculating step comprises deciding whether a sample should be added or removed on basis of at least one of the following inputs;

- the sample frequencies of sending (TRX1) and receiving (TRX2) terminal units;
- a voice activity detector signal;
- status of the playout buffer; and
- an indicator of the beginning of a talkspurt

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6. The method of any of the preceding claims **characterised** in that the generating step comprises

selecting the position where in the LPC residual to add or remove a sample; and

performing said adding respective removing of said sample.

7. The method of claim 6 further **characterised** by selecting said position arbitrarily.

8. The method of claim 6 further **characterised** in that said position is found by searching for a segment of the LPC-residual with low energy.

9. The method of claim 8 further **characterised** in that said segment of low energy is found by using a block energy analysis.

10. The method of claim 8 further **characterised** in that said segment of low energy is found by using a sliding window energy analysis.

11. The method of claim 6 further **characterised** in that said position is found by using knowledge about the position of a pitch pulse together with knowledge about a time difference

between said pitch pulse and the following pitch pulse to select the position where to add or remove a sample in the LPC-residual.

12. The method of claim 11 further **characterised** in that said pitch pulse is found by searching for positions in the LPC residual with high energy.

13. The method of claim 12 further **characterised** in that said positions with high energy are found by using a block energy analysis.

14. The method of claim 12 further **characterised** in that said positions with high energy are found by using a sliding window energy analysis.

15. The method of claim 6 further **characterised** in that said adding of a sample is done by adding a zero sample.

16. The method of claim 6 further **characterised** in that said adding of a sample is done by adding a zero sample and interpolating surrounding samples.

17. The method of claim 6 further **characterised** in that said removing of a sample is done by removing a sample from the LPC-residual.

18. The method of claim 6 further **characterised** in that said adding of a sample is done by adding a sample in the history of the LPC residual; and

increasing a lag pointer as long as the adding is within the LPC residual history.

19. The method of claim 6 further **characterised** in that said removing of a sample is done by removing a sample in the history of the LPC residual; and

decreasing a lag pointer as long as the removing is within the LPC residual history.

20. The method of claim 6 wherein the second terminal unit comprises an adaptive and a fixed codebook

the method further **characterised** in that said adding of a sample is done by

adding a sample in the output from the adaptive codebook;

extending the output from the fixed codebook; and

increasing a lag pointer as long as the adding is within the LPC residual history.

21. The method of claim 6 wherein the second terminal unit comprises an adaptive and a fixed codebook

the method further **characterised** in that said removing of a sample is done by

removing a sample in the output from the adaptive codebook;

shortening the output from the fixed codebook; and

decreasing a lag pointer as long as the removing is within the LPC residual history.

22. The method of claim 6 wherein the second terminal unit comprises a fixed codebook

the method further **characterised** in that said adding or removing of a sample is done by

adding or removing a sample in the output from the fixed codebook.

23. An apparatus for improving speech quality in a communication system comprising a first terminal unit (TRX1) transmitting speech signals and having a first sampling frequency (F_1) and a second terminal unit (TRX2) buffering said speech signals in a playout buffer with said first frequency (F_1) and playing them out with a second frequency (F_2), said apparatus

characterised by

means for performing a dynamic sample rate conversion of a speech frame comprising N samples on a sample by sample basis, said dynamic sample rate conversion further characterised by

means for creating an LPC-residual, comprising N samples, derived from said speech frame;

means for calculating for each speech frame whether a sample should be added or removed from said LPC-residual;

means for generating a modified LPC-residual comprising of N-1 or N+1 samples, if said calculating so demands; and

means for synthesising a speech signal from said modified LPC-residual.

24. The apparatus of claim 23 wherein the means for creating is **characterised** by further comprising means for performing an LPC-analysis of the speech frame to find the LPC-parameters of said speech frame.

25. The apparatus of claim 23 wherein the means for creating is **characterised** by further comprising means for using existing LPC-parameters from a speech decoder.

26. The apparatus of claim 23 wherein the means for creating is **characterised** by further comprising means for using an existing LPC-residual from a decoder.

27. The apparatus of any of claims 23-26 wherein the means for calculating is **characterised** by further comprising means for deciding if a sample should be added or removed on the basis of a function of at least one of the following inputs:

- sample frequencies of sending and receiving terminal units;
- a voice activity detector signal;
- status of the playout buffer; and
- an indicator of the beginning of a talkspurt.

28. The apparatus of any of claims 23-27 wherein the means for generating is **characterised** by further comprising

means for selecting the position where to add or remove samples; and

means for performing said adding and removing.

29. The apparatus of claim 28 wherein the means for selecting is further **characterised** by means for arbitrarily selecting said position where to add or remove samples.

30. The apparatus of claim 28 wherein the means for selecting is further **characterised** by means for searching for the segment of the LPC-residual with the lowest energy.

31. The apparatus of claim 30 wherein the means for searching is further **characterised** by means for performing a block energy analysis.

32. The apparatus of claim 30 wherein the means for searching is further **characterised** by means for performing a sliding window energy analysis.

33. The apparatus of claim 28 wherein the means for selecting is further **characterised** by means for using knowledge about the position of a pitch pulse together with knowledge about a time difference between said pitch pulse and the following pitch pulse to select the position where to add or remove a sample in the LPC-residual.

34. The apparatus of claim 33 wherein the means for using knowledge about pitch pulses is further **characterised** by means for finding the pitch pulses by searching for positions in the LPC residual with high energy.

35. The apparatus of claim 34 wherein the means for finding pitch pulses is further **characterised** by means for performing a block energy analysis.

36. The apparatus of claim 34 wherein the means for finding pitch pulses is further **characterised** by means for performing a sliding window energy analysis.

37. The apparatus of claim 28 wherein the means for performing adding or removing is further **characterised** by means for adding a zero sample.

38. The apparatus of claim 28 wherein the means for performing adding or removing is further **characterised** by means for removing a sample from the LPC-residual.

39. The apparatus of claim 28 wherein the means for performing adding or removing is further **characterised** by

means for adding a zero sample and interpolating surrounding samples.

40. The apparatus of claim 28 wherein the means for performing adding or removing is further **characterised** by

means for adding a sample in the history of the LPC residual; and

means for increasing a lag pointer as long as the adding is within the LPC residual history.

41. The apparatus of claim 28 wherein the means for performing adding or removing is further **characterised** by

means for removing a sample in the history of the LPC residual; and

means for decreasing a lag pointer as long as the removing is within the LPC residual history.

42. The apparatus of claim 28 wherein the second terminal unit comprises an adaptive and a fixed codebook

the apparatus further **characterised** by

means for adding a sample in the output from the adaptive codebook;

means for extending the output from the fixed codebook; and

means for increasing a lag pointer as long as the adding is within the LPC residual history.

43. The apparatus of claim 28 wherein the second terminal unit comprises an adaptive and a fixed codebook

the apparatus further **characterised** by

means for removing a sample in the output from the adaptive codebook;

means for removing a sample in the output from the fixed codebook; and

means for decreasing a lag pointer as long as the removing is within the LPC residual history.

44. The apparatus of claim 28 wherein the second terminal unit comprises a fixed codebook

the apparatus further **characterised** by

means for adding or removing a sample in the output from the fixed codebook.